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BIO-
DESIGN
INC

OPERATING INSTRUCTIONS

MICROGUARD®

MODEL MG-2A

INSTRUCTION MANUAL

MICROGUARD® SAFETY TESTER

Model MG-2 A

For use with MICROGUARD serial numbers

20800 and higher

Printed in U.S.A.
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BIO-DESIGN, INC.
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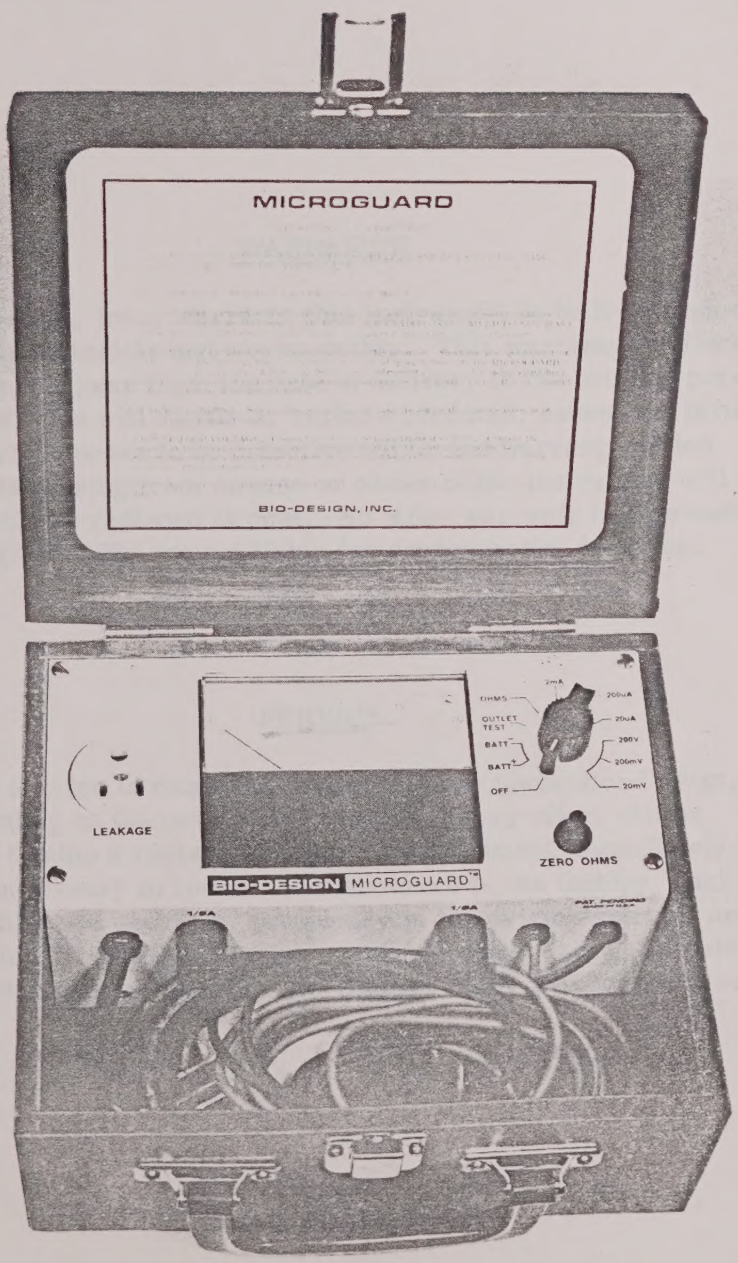
MICROGUARD
BIO-DESIGN, INC.
OHMS
OUTLET TEST
BATT-
BATT+
OFF
2mA
200uA
20uA
200V
200mV
20mV
LEAKAGE
ZERO OHMS
BIO-DESIGN MICROGUARD™
1/8A
1/8A

WARRANTY

Bio-Design, Inc., warrants this instrument to be free from defects in materials and workmanship. This warranty is effective for one year from the date of delivery to the original purchaser. We will repair or replace products, except for batteries, which prove to be defective within the warranty period. Defects arising from misuse or abuse of the instrument will be repaired or replaced at cost. No other warranty is expressed or implied. We are not liable for consequential damages.

SERVICE

When service is required, write, wire or phone Bio-Design, Inc. Depending on the nature of the defect, every effort will be made to ship a replacement part or instrument immediately. If it is necessary to return the instrument to the factory, pack carefully and securely, preferably in the original carton, and return it to Bio-Design, Inc., with shipping charges prepaid. Do not return products to Bio-Design, Inc., without prior consent.

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I.

II.

WARNING

When an electrically-operated device is plugged into the Leakage receptacle of this instrument, the safety grounding wire of the device-under-test is defeated. In the event of a line-to-chassis fault in the device-under-test, its chassis could be at line voltage. Therefore, DO NOT TOUCH the chassis of the device-under-test and any grounded metal object at the same time.

III.

IV.

V.

CONTENTS

I. GENERAL INFORMATION

1.0 Introduction
2.0 Specifications
3.0 Special Features
4.0 Accessories

II. OPERATING INFORMATION

1.0 Initial Installation
2.0 Controls
3.0 Inputs and Outputs
4.0 Meter Scales
5.0 Leakage Current and Electrical Hazards
6.0 Bibliography

III. HOSPITAL SAFETY-CHECK PROCEDURE

1.0 Introduction
2.0 Operating Instructions

IV. TESTING UNGROUNDED CIRCUITS

1.0 Introduction
2.0 Requirements for Ungrounded Circuits
3.0 Test Procedure

V. TESTING BEDSIDE AND CENTRAL STATION MONITORS

1.0 Introduction

CONTENTS, cont'd.

V. TESTING BEDSIDE AND CENTRAL STATION MONITORS, cont'd.

2.0 Test Procedure

VI. OTHER MICROGUARD USES

1.0 Resistance Measurements
2.0 Current Measurements
3.0 Voltage Measurements
4.0 Leakage Current of 2-Wire Appliances

VII. MAINTENANCE

1.0 Introduction
2.0 To Remove Front Panel
3.0 To Replace Batteries
4.0 To Replace Input Fuse
5.0 To Replace AC Fuse
6.0 Meter Mechanical Zero Adjustment
7.0 Electrical Zero Adjustment
8.0 Calibration

I. GENERAL INFORMATION

1.0 INTRODUCTION

The Bio-Design MICROGUARD is a compact, rugged, easy-to-operate instrument designed for testing the safety and integrity of electronic and electrical equipment and AC power outlets in sensitive areas, such as hospitals, doctors' and dentists' offices, nursing homes, laboratories, assembly lines or any other area where people come in contact with electrical equipment. MICROGUARD is especially valuable in hospitals where patients are often connected to equipment by means of excellent conductors such as ECG electrodes or intravascular catheters. MICROGUARD will test three-wire 115VAC receptacles for proper wiring. It will measure tiny ground loop voltages or power line voltages. It will check continuity of ground wires, electrodes, chassis connections or cables.

MICROGUARD can also be used as a general purpose instrument to accurately measure AC and DC voltage and current, and resistance. It will indicate voltages as low as 0.5 millivolts and currents as low as 0.5 microampere. The resistance scale is calibrated 0 to 2 ohms.

MICROGUARD is completely portable, using two long-life mercury batteries. Integrated circuits and precision components are used to insure reliability and accuracy. A 3-1/2 inch meter with 3-color dial is featured for easy readability.

2.0 SPECIFICATIONS

2.1 Accuracy: Voltage and current: within ± 3% of full scale on all ranges at DC and 60Hz. Ohms: within ± 5% of reading when properly zeroed.

2.2 Frequency Response: DC and 20 to 1000Hz (-1db). NOTE: The meter will indicate the absolute value of direct current and voltage, regardless of polarity, and the RMS value of a sinusoidal AC waveform.

2.3 Input Impedance:

2 mA	500 ohms ± 2%
200 uA	500 ohms ± 2%
20 uA	500 ohms ± 2%
200 V	1.0 Meg ± 2%
200 mV	500 ohms ± 2%
20 mV	500 ohms ± 2%

2.4 Outlet Test: Tests for proper wiring at 115VAC ± 10%.

2.5 Power Supply: Two Mercury batteries, Mallory type TR134.

2.6 Input Protection: On the current and resistance ranges, the input circuit is protected from damage due to accidental contact with line voltage by means of 2 fast-blow, 1/8 ampere fuses, one in series with each test lead. These fuses are accessible from the front panel. As a general rule avoid connecting the MICRO-GUARD leads to any voltage source while the selector switch is in the current or resistance positions. Never

exceed 250 V DC or RMS at the input.

The MICROGUARD meter is protected by special circuitry and cannot be damaged by input overloads.

2.7 AC Line Cord Protection: The line cord is fused with a 10 ampere fuse, located inside the MICROGUARD and accessible by removing the front panel. Do not plug instruments into the LEAKAGE receptacle whose AC load exceeds 10 amperes.

2.8 Dimensions: 7-1/2 inches deep X 8-15/16 inches wide X 4-3/4 inches high. Handle projects 5/8 inches from front surface.

2.9 Weight: 5 lbs.

3.0 SPECIAL FEATURES

3.1 Test Leads: Two 6-foot test leads, one red and one black, are an integral part of the MICROGUARD and cannot be lost or mislaid. Each lead has a 5-1/4 inch test prod with phone tip.

3.2 Line Cord and Plug: The line cord is heavy-duty, vinyl-covered, 3-conductor type, 5-feet in length. A rugged power plug is used to insure safety and long life.

4.0 ACCESSORIES

4.1 Alligator Clips: Two insulated alligator clips, one red and one black, are included. These fit over the test prod tips.

4.2 Clip Lead: A 10-foot clip lead is provided for convenience in making measurements between remote points.

4.3 Safety-Check Stickers: Fifty Safety-Check Stickers are included with each MICROGUARD to facilitate the periodic inspection and maintenance of equipment and instruments. Record the appropriate information on the Safety-Check Stickers, peel off the backing, and apply the sticker to the tested instrument. Additional stickers may be purchased from Bio-Design, Inc.

4.4 Spare Fuses: Spare fuses are included with each MICROGUARD.

II. OPERATING INFORMATION

1.0 INITIAL INSTALLATION

After opening the shipping carton, inspect the MICROGUARD for signs of physical damage. If damage is found, or if the instrument does not meet specifications, notify the carrier and notify Bio-Design, Inc., in writing.

The MICROGUARD is ready for use as soon as it is unpacked and opened. No initial adjustment or calibration is necessary.

2.0 CONTROLS

2.1 Selector Switch: This switch selects the function and range as described below:

OFF: The MICROGUARD is off in this position and there is no battery drain. Always return the switch to this position after use to conserve battery life.

BATT+, BATT-: These two positions check the voltage of the two batteries which power the MICROGUARD. If the meter pointer does not fall in the area marked "BATT OK", replace the batteries immediately. Section VII paragraph 3.0 gives instructions.

OUTLET TEST: This position is used for testing the proper wiring of 115 VAC, 3-wire power outlets.

OHMS: This position is used for checking continuity of ground wires and other conductors and for measur-

ing resistance in the range 0 to 2 ohms.

2mA, 200uA, 20uA: These ranges are used for measuring AC and/or DC currents from 0.5 microamperes to 2 milliamperes maximum. The meter will indicate the absolute value of direct current, regardless of polarity, and the RMS value of alternating current.

200V, 200mV, 20mV: These ranges are used for measuring AC or DC voltages from 0.5 millivolts to 200 volts maximum. The meter will indicate the absolute value of a DC voltage, regardless of polarity and the RMS value of an AC voltage from 20Hz to 1000Hz.

2.2 Zero Ohms: This control is adjusted to obtain 0 ohms on the meter scale when the selector switch is on OHMS and the test leads are shorted together.

3.0 INPUTS AND OUTPUTS

3.1 Test Leads: Two 6-foot test leads, one red and one black, are provided for measuring resistance, current, and voltage. These leads are connected to the MICRO-GUARD input circuitry only in the OHMS, 2mA, 200uA, 20uA, 200V, 200mV and 20mV positions and are disconnected in the OUTLET TEST, BATT TEST, and OFF positions.

3.2 Power Plug: The power plug is used for testing 115 volt AC outlets, and for bringing power to the front panel

4.0

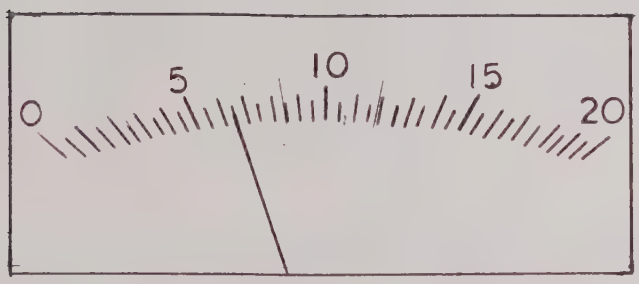
"LEAKAGE" receptacle. The black and white wires are wired directly to the blades of the LEAKAGE receptacle so that voltage is present on the receptacle whenever the plug is connected to an AC source. The black wire is fused with a 10 ampere fuse which is located inside the MICRO-GUARD. The green wire of the plug is connected to the MICROGUARD panel.

3.3 LEAKAGE Receptacle: This receptacle provides AC power to equipment whose leakage current is to be measured. The blades of this receptacle are live whenever the MICROGUARD power plug is plugged into an AC source. The U-ground of this receptacle is wired directly to the red test lead. It is not wired directly to the power plug ground prong, so that in the current ranges a small sensing resistor is switched in.

4.0 METER SCALES

4.1 Main Scale: The main scale is calibrated 0 to 20. The full-scale value of the meter is determined by the range to which the selector switch is set. Thus, if the selector switch is set at 2 mA, a meter reading of 20 corresponds to actual input current of 2 mA. Likewise, if the selector switch is set at 200V, a reading of 20 corresponds to actual measured voltage of 200 volts. Table 1 gives examples of actual measured values for a typical meter reading.

4.3



Range	Meter Reading	Actual Value
2mA (2000uA)	6.5	.65mA (650uA)
200uA	6.5	65uA
20uA	6.5	6.5uA
200V	6.5	65V
200mV	6.5	65mV
20mV	6.5	6.5mV
OHMS	6.5	.65 ohms

mA = milliamperes, uA = microamperes
V = volts, mV = millivolts

Table 1.

4.2 Ohms Scale: The Ohms scale is calibrated 0 to 2 ohms, with the 0 at the left hand end of the scale. If the meter needle points to 20, the measured resistance is 2 ohms. If the meter needle reads to the right of the 20 mark, the measured resistance is greater than 2 ohms. Open circuiting the test leads will also cause the meter to read to the right of the 20 mark.

4.3 Outlet Test: Four colored arcs display the condition of 3-wire 115 VAC outlets when the selector switch is on OUTLET TEST. If the meter pointer rests within the green arc marked "OK", the outlet being tested is wired with the proper polarity and the ground connection is intact. If the pointer rests in the red arc marked "NO GND", the outlet ground connection is broken or not wired.

In such places as operating rooms, where isolation transformers are used to create an isolated 115 VAC supply, the MICROGUARD will generally indicate "NO GND". However, the indication may vary from one location to another because of the leakage paths supplied by other equipment or by the transformer and its associated wiring.

If the pointer rests in the red arc marked "HOT GND", the hot wire and the ground wire are interchanged and 115 VAC is present on the ground socket.

CAUTION: This is a rare but dangerous condition as the entire case or chassis of equipment connected to this outlet may be live, including the MICROGUARD panel. Therefore when making outlet tests, do not touch the MICROGUARD panel, or any other equipment, until after the MICROGUARD plug has been inserted into the outlet under test and its condition has been determined.

If the pointer rests in the red arc marked "POL REV", the "Hot" and "Neutral" wires of the outlet under test are reversed but the ground connection is intact. If an indication of 0 is obtained, there is either no voltage or no neutral connection. Use the test leads and the 200V scale to verify.

5.0 LEAKAGE CURRENT AND ELECTRICAL HAZARDS

A hospital electrical safety program should have two primary goals: (1) preventing gross 115 VAC shocks to personnel and patients, resulting from faulty wiring or breakdown of equipment and insulation, and (2) preventing "Micro-shock" due to AC or DC leakage currents finding a path through a patient instead of through secure, low-impedance ground connections.

The major effect of electric shock is ventricular fibrillation, a condition in which the heart does not pump blood, and which if not detected and treated, results in death. 60 hz AC current as low as 10 to 20 microamperes passing directly through the heart muscle may cause ventricular fibrillation. This current may result from 100 milliampere currents passing through the arms and legs, or 10 milliampere currents piercing the skin by means of needle electrodes, dye-injectors, blood-pressure transducers, or the like, or it may be applied directly to the heart through such means as pacemaker leads. Whatever the source, the ultimate danger is from the current which passes directly through the heart. While it is beyond the scope of this manual to explore in detail the many complex aspects of electric shock (the operator is referred to the Bibliography found at the end of this section), Figures 1 through 5 show some of the hazardous situations which MICROGUARD will detect if used in a regular, systematic preventive maintenance program.

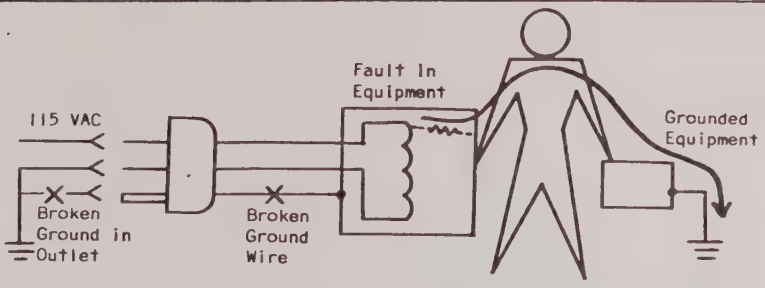


Figure 1. Gross shock due to lack of ground

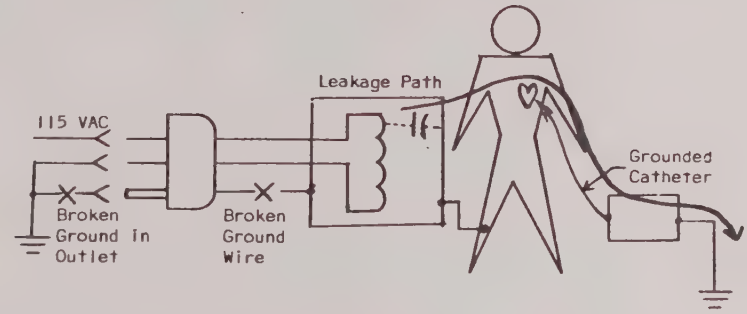


Figure 2. Micro-shock due to lack of ground

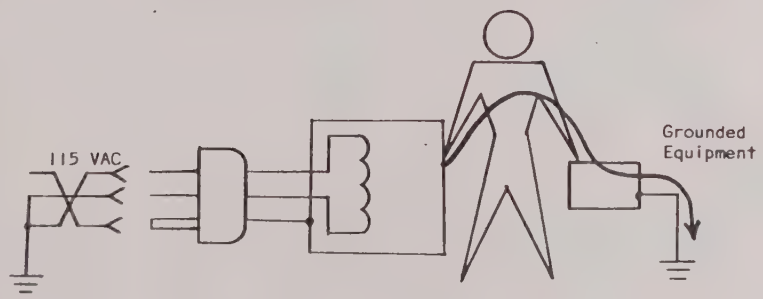


Figure 3. 115 VAC shock due to "hot" ground

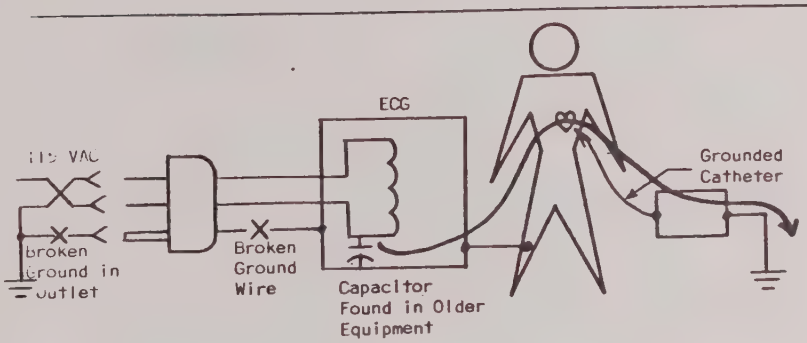


Figure 4. Micro-shock due to reversed polarity

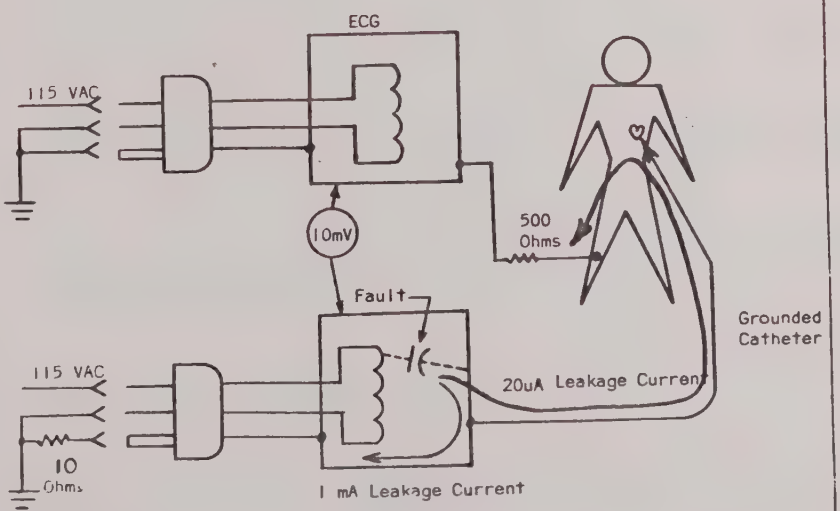


Figure 5. Micro-shock due to ground-loop voltage (non-equipotential grounds)

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III. HOSPITAL SAFETY-CHECK PROCEDURE

1.0 INTRODUCTION

The MICROGUARD is ideally suited for use in hospitals as an all-purpose safety test instrument. Shock hazards will be greatly reduced through the use of the MICROGUARD in a regular, systematic preventive maintenance program. This program should include all the following steps to insure a safe electrical environment:

(1) Check integrity of AC outlets
(2) Check equipment plugs and grounds
(3) Check cables (Power and Patient) for continuity
(4) Check leakage current of equipment
(5) Check area for equipotential grounds

The use of Bio-Design Safety-Check adhesive labels to identify equipment which has been safety-tested will simplify and expedite your program.

2.0 OPERATING INSTRUCTIONS

2.1 Battery Check: Always check the MICROGUARD batteries before using to insure accurate performance.

Turn selector switch to BATT+ and BATT-. If in either position the meter reads to the left of "BATT OK", change the batteries as instructed in Section VII, paragraph 3.0.

2.2 Outlet Test: (Figure 6) Turn selector switch to OUTLET TEST. Insert MICROGUARD plug into all 3-wire 115 VAC

receptacles in the area. If any reading other than "OK" is obtained, immediate action should be taken to correct the existing condition.

CAUTION: The "HOT GND" condition is a rare but dangerous condition in that the entire case or chassis of equipment connected to this outlet may be live, including the MICROGUARD panel. Therefore, when making outlet tests, do not touch the MICROGUARD panel, or any other equipment until after the MICROGUARD plug has been inserted into the outlet under test, and its condition has been determined.

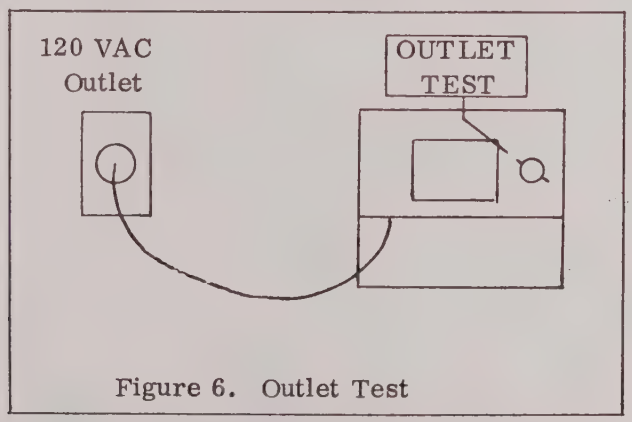

Figure 6. Outlet Test

2.3 Continuity of Grounding Wire in 3-Prong Power Plugs: (Figure 7)

(1) Set Selector Switch to OHMS.

(2) Short red and black test leads together and slowly adjust ZERO OHMS control until meter needle rests as far to the left as possible. (Over-adjustment will cause the needle to move back to the right)

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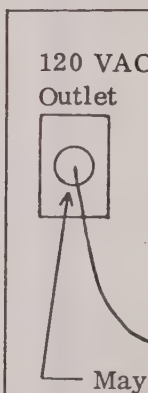


Figu

(3) Insert the power plug to be tested into the MICROGUARD receptacle. Connect the Black test lead to an exposed metal part of the chassis of the equipment-under-test. The meter should indicate 0 ohms. If the indication is several ohms, an intermittent, partial or corroded connection may be present and should be repaired. If high or infinite resistance is indicated, a faulty plug or broken wire is present and should be repaired. If the ground wire is satisfactory, place a check mark in the appropriate box on a Bio-Design Safety-Check Sticker.

(4) Alternate method: perform steps (1) and (2). Connect one test lead to the chassis of the equipment-under-test. Connect the other test lead to the power plug ground prong and observe the meter indication.

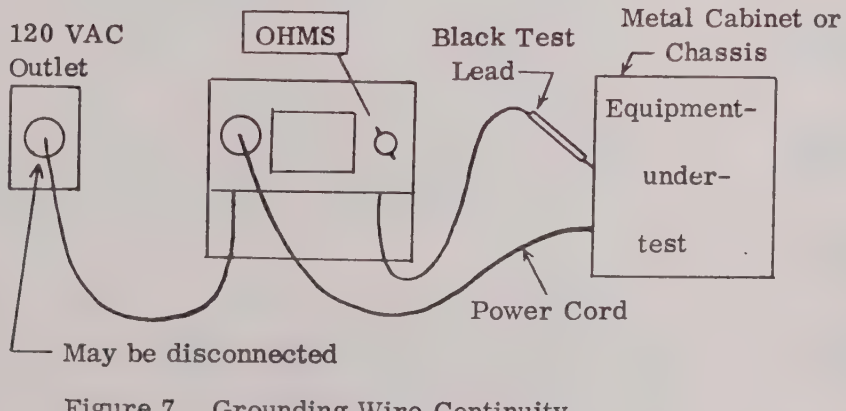


Figure 7. Grounding Wire Continuity

2.4 Leakage Current of Equipment: (Figure 8)

(1) Turn the selector switch to 2 mA.
(2) Insert the power plug of the equipment to be tested into the MICROGUARD receptacle.
(3) Insert the MICROGUARD power plug into the AC outlet to which the equipment under test will be connected.
(4) If there is no meter reading, turn to 200 uA or 20 uA until a reading is obtained.

NOTE: Do not allow the red and black test leads to short together as this will bypass the current sensing resistor in the MICROGUARD and no reading will be obtained.

(5) If "excessive" leakage current is measured, the equipment may be unsafe for use in the intended area or may have an electrical fault and be in need of repair. See Section below entitled, "Discussion".
(6) Record the reading obtained on a Bio-Design Safety-Check Sticker, or a log book for comparison with future readings. A marked or excessive increase in leakage currents between two successive readings indicates an impending or existing fault in the equipment under test.

DISCUSSION: At present, there are no standards for determining what may be considered "excessive" leakage. It must be viewed in the light of the procedures to be performed in the particular room or area in which the equipment will be used, or in the light of the present or future usage of the equipment itself. In

catheterization laboratories, equipment leakage should not exceed 10 microamperes AC. Likewise, internal pacemakers should not possess more than 10 microamperes AC. Instruments used in the vicinity of "non-sensitive" patients (those who are not catheterized) may possess up to 100 microamperes. As standards on leakage current become available, Bio-Design, Inc., will attempt to keep MICROGUARD users informed. In any case, the decision to use equipment with excessive leakage must be made by the responsible medical authority.

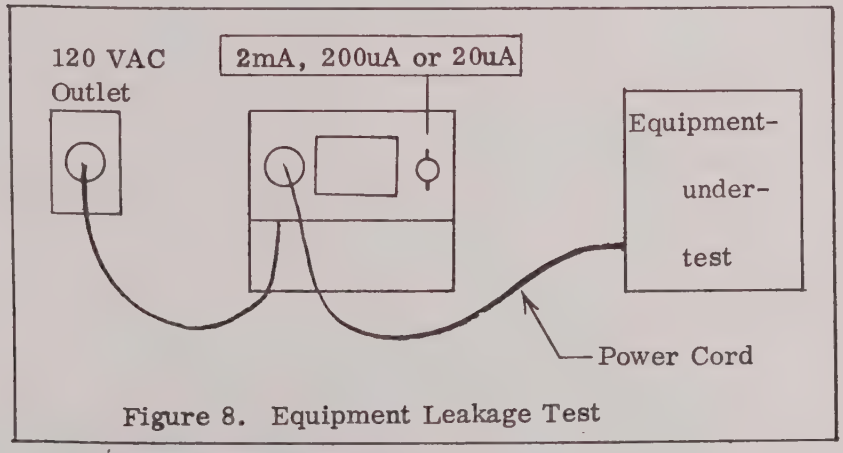


Figure 8. Equipment Leakage Test

2.5 Outlet Ground Resistance Test: (Figure 9)
Check outlet grounds to insure that they are low resistance.

(1) Disconnect MICROGUARD plug from AC outlet.

(2) Turn the selector switch to OHMS.
(3) Zero the ohms scale: short the red and black test leads together and adjust the ZERO OHMS control for a meter reading of 0 ohms.
(4) Connect one test lead of the MICROGUARD to a convenient, certain ground, such as a coldwater pipe.
(5) Connect the other test lead to the ground socket of the outlet under test. The meter should indicate 0 ohms. A reading of several ohms or higher indicates an inadequate ground which should be repaired.

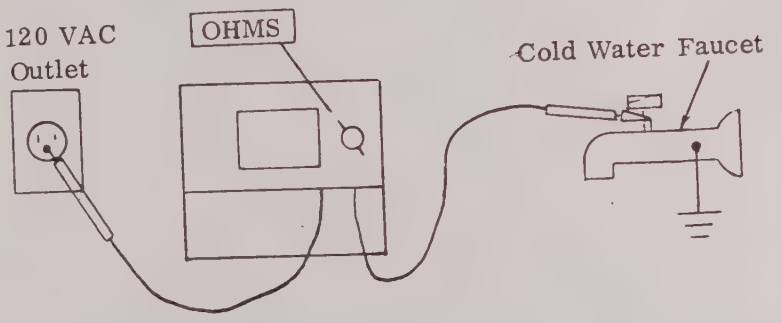


Figure 9. Outlet Ground Resistance Test

2.6 Ground Loop Voltages: (Figure 10)
Perform this test in sensitive areas periodically or prior to connecting electronic instruments to a patient.

(1) Disconnect MICROGUARD plug from AC outlet.
(2) Turn selector switch to 20 mV.
(3) Connect one test lead of MICROGUARD to ground socket of one receptacle.

2.7

(4) Insert other test lead into ground socket of all other 3-wire receptacles in the area. If the voltage measured is larger than 5 millivolts, the area grounds are not equipotential, but possess a voltage difference which may be a source of leakage current to patients. If this is the case, the use of an "equalizing ground bus" is recommended. (Contact Bio-Design, Inc., for further details)

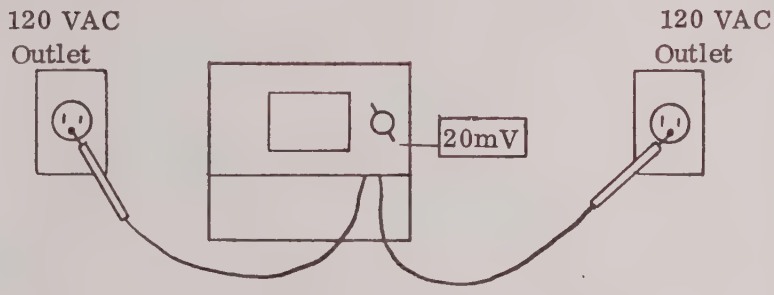


Figure 10. Ground-Loop Voltages

2.7 Leakage Currents Between Equipment: (Figure 11) Perform this test immediately before connecting electrically-operated devices to patients, especially before catheterization, internal pacing, or any other procedure which violates the skin.

(1) Disconnect MICROGUARD plug from AC outlet.
(2) Turn selector switch to 20 uA.
(3) Connect one test lead to an established electrical ground, such as a cold-water pipe, faucet, or properly grounded AC outlet.

(4) With the other test lead, touch exposed metal surfaces of all other electrically-operated equipment in the area. Also apply to patient electrodes. Typical equipment which should be checked includes:

Electrocardiographs
Electroencephalographs
Cardiac Monitors
Physiological Monitors
Blood Pressure Transducers
Respiration Monitors
Intravascular Catheters
Bovie or Electrosurgery Machines
Anesthesia Masks
Suction Pumps
Inhalators
Respirators
Televisions
Radios, AC operated
Electric Beds
Any electrical device which a patient may intentionally or accidently touch.

(5) All readings should be zero (0).
If the MICROGUARD meter indicates excessive leakage between any of the above objects, a hazardous situation exists, which requires the removal or replacement of equipment or the use of an equalizing ground bus or isolation transformer.

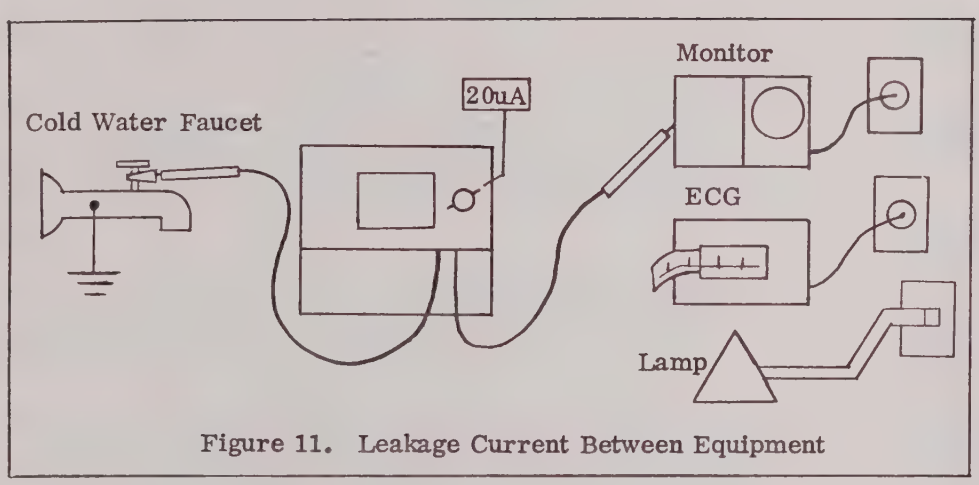


Figure 11. Leakage Current Between Equipment

IV. TESTING UNGROUNDED CIRCUITS

1.0 INTRODUCTION

The Bio-Design MICROGUARD® Safety Tester can be used for making quick and convenient checks of "ungrounded" or "isolated" 120 VAC circuits, such as those found in hospital operating rooms. First, a discussion of isolated circuits is in order.

Isolated circuits, that is AC circuits which are fed from isolation transformers, are required in all operating rooms because they offer the following benefits:

1.1 No arc or spark hazard from accidental grounding of the line. Accidental grounding of a normal circuit produces an arc which could be extremely dangerous in the presence of oxygen and explosive anesthetics. In an isolated circuit, grounding either side of the line causes that side to become ground and the other side to become the "hot" side. Thus, the danger or arcing is virtually eliminated.

1.2 Elimination of Shock Hazard

Operating rooms have conductive floors and doctors and nurses wear conductive boots in order to minimize sparking due to build-up of static electricity. Because the personnel are so well grounded, the danger of shock from accidental contact with line voltage is greatly increased. An isolated system reduces the shock hazard because the side which is contacted instantly becomes "ground".

1.3 Reduction of AC Leakage Current

Another advantage of isolated circuits is the considerable reduction of 60 hz AC leakage current in equipment ground wires. In Figure 12, a conventional grounded circuit, Point A, is at line potential and leakage current flows through the stray capacitance to the chassis and back through the ground wire. In Figure 13, an isolated circuit, current can flow from the "hot" side through the primary-to-secondary capacitance of the isolation transformer, through Point A to the chassis. The primary-to-secondary capacitance of the transformer is usually much smaller than the capacitance from Point A to chassis; therefore, very little leakage current will flow in the equipment ground wire.

Low leakage current is important in catheterization, pacemaking or other procedures in which the patient's skin is violated.

2.0 REQUIREMENTS FOR UNGROUNDED CIRCUITS

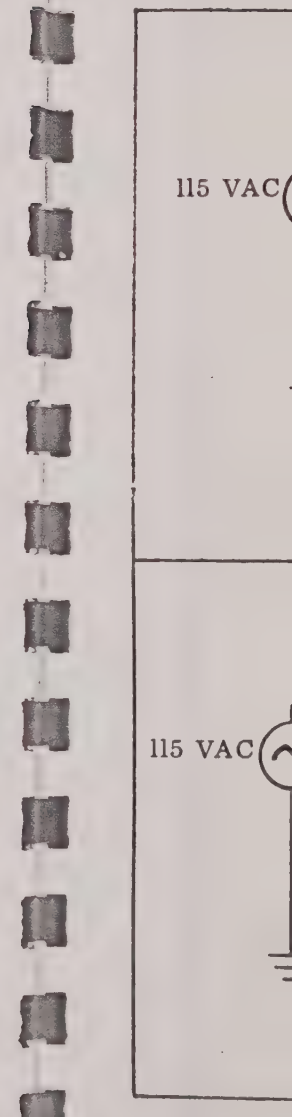
The National Fire Protection Association's Code for the Use of Flammable Anesthetics (NFPA 56, Art. 244), requires that each ungrounded system be provided with a ground fault indicator that signals when the fault resistance or capacitive reactance from either conductor to ground is less than 60,000 ohms, which would result in fault current exceeding 2 milliamperes. Some organizations, such as the Veterans Administration, are recommending 1 milliampere as the limit. Whatever the limit, it is desirable to measure the actual hazard current present periodically to assure that the ground fault indicator is operating properly. The MICROGUARD will measure these currents

when used as indicated below.

3.0 TEST PROCEDURE

(1) Disconnect MICROGUARD power plug from AC outlet.
(2) Set MICROGUARD selector switch to 2mA.
(3) Connect the black test lead to a known reference ground.
(4) Connect the red test lead to one side of the ungrounded circuit and note reading. An adapter may be necessary if locking type receptacles are used on the isolated circuit.
(5) Connect the red test lead to the other side of the ungrounded circuit and note reading. The highest of the two readings represents the maximum fault current which will flow if one side of the ungrounded circuit becomes grounded.

NOTE: The ground-fault indicator alarm should go on when the MICROGUARD is connected from one side of the isolated circuit to ground. This is normal, and indicates the alarm circuit is working properly.



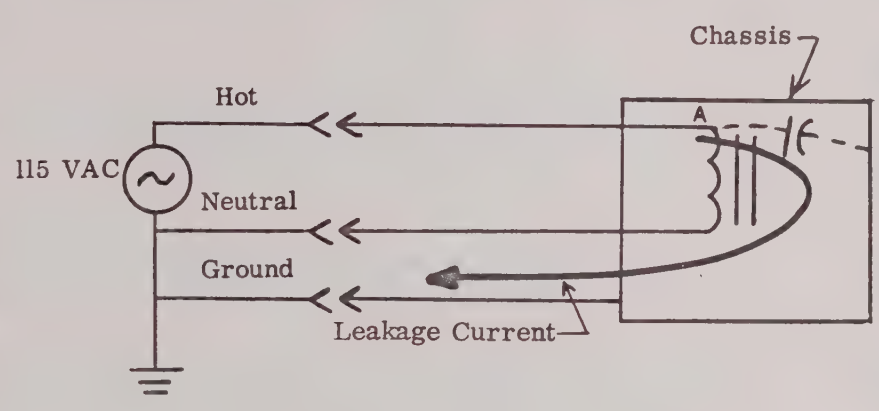


Figure 12. Leakage Current in grounded system

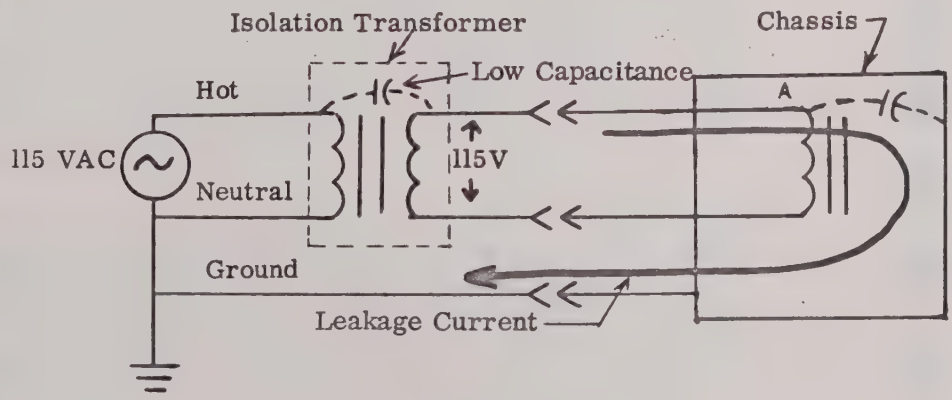


Figure 13. How Isolation reduces leakage current

V. TESTING BEDSIDE AND CENTRAL STATION MONITORS

1.0 INTRODUCTION

Unusual readings frequently arise when measuring leakage current of bedside and central station monitors with the MICROGUARD™ Safety Tester. For example:

(1) Zero leakage current.
(2) The meter pulsates at a rate identical, strangely enough, to the heart rate of the patient being monitored.

These symptoms arise in patient monitoring systems where the bedside and remote monitor are connected by a signal cable in which the shield or separate ground wire is carried through. This creates a troublesome "ground loop", as the diagrams illustrate.

Figure 14 shows the leakage current of the instrument under test being shorted to ground by means of the bedside-to-remote signal cable, thus the meter reads 0 leakage current. We know that zero leakage is impossible, because we should at least measure the leakage current of the monitor line cord, typically 1 to 2 microamperes per foot.

Figure 15 shows why the MICROGUARD meter will sometimes pulsate at the patient's heart rate. The patient's ECG signal current is transmitted from the bedside amplifier over the signal wire to the central station monitors. Since electrical circuits must have a continuous path, the ECG signal current returns through a ground wire or through the cable shield. However, some of the signal current may flow through an

alternative path to return to the bedside amplifier,(in this case through the MICROGUARD) thus causing the meter to pulsate.

In some of the newer monitoring systems, this condition is eliminated because the manufacturers use "differential" output amplifiers, which "float" the signal above ground, and do not require the ground wire as a return path for the signal current. It is definitely advisable to have the cable shield grounded only at one point, either at the bedside monitor, or the remote monitor.

2.0 TEST PROCEDURE

2.1 Before measuring leakage current of bedside monitors, disconnect the output signal cable from the bedside monitor. (The output signal cable is usually located at the back of the bedside monitor and connects to a special wall receptacle. It is sometimes labeled "To Remote".) This eliminates the troublesome ground loop and results in accurate leakage current readings.

Be sure to inform the ICU nurse that you are disconnecting the signal to the central monitor.

2.2 Measure leakage current using the procedure of Section III, paragraph 2.4. The measurement only takes a few seconds and often the cable plug can be re-connected before the alarms go on.

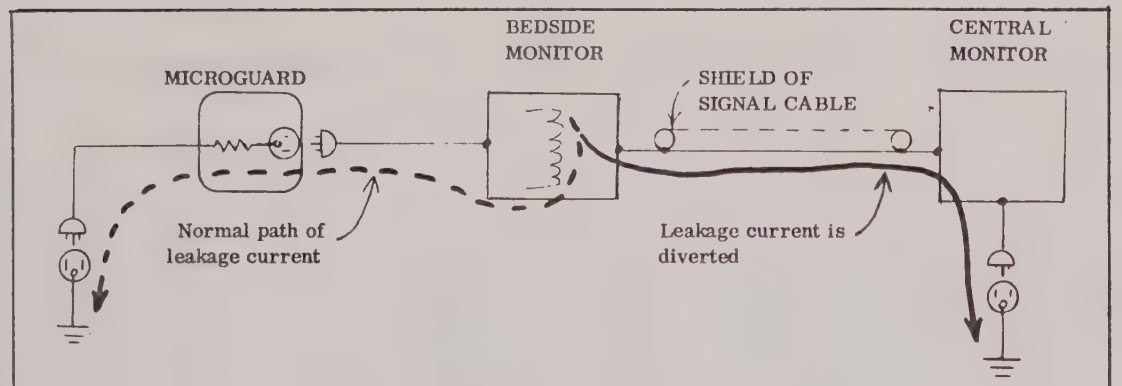


Figure 14. Zero Leakage Current

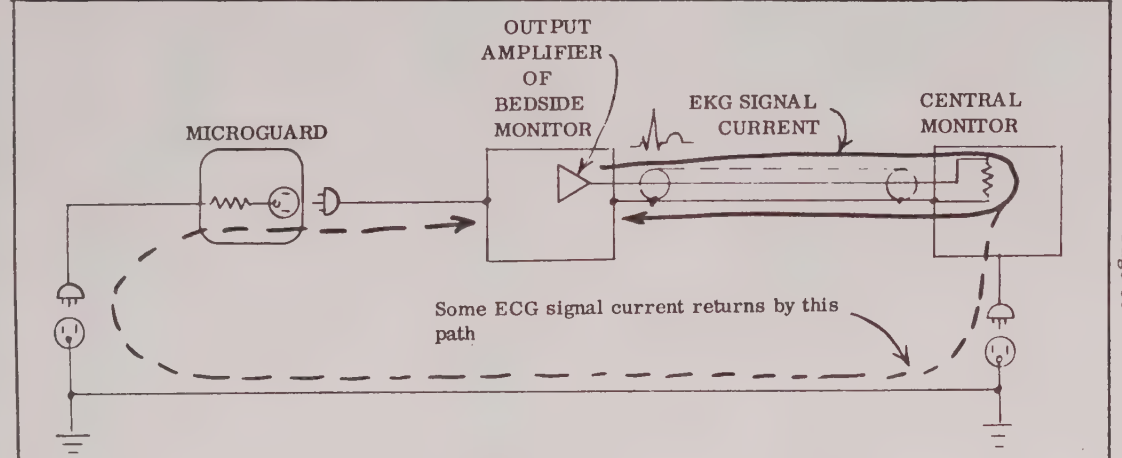


Figure 15. Pulsating Meter

VI. OTHER MICROGUARD USES

1.0 RESISTANCE MEASUREMENTS (0 to 2 ohms)

(1) Disconnect MICROGUARD plug from AC Outlet.
(2) Turn selector switch to OHMS.
(3) Short the red and black test leads together and adjust the ZERO OHMS Control for a meter reading of 0 ohms.
(4) Connect the test leads to the unknown resistor and read the resistance on the ohms scale of the meter.

CAUTION: Do not make resistance measurements in a circuit in which live voltages are present, or erroneous readings will result.

Figure 15. Pulsating Meter

2.0 CURRENT MEASUREMENTS

The MICROGUARD may be used as a sensitive AC or DC micro-ammeter. It will indicate the absolute value of direct current, regardless of polarity, and the RMS value of alternating current.

(1) Disconnect MICROGUARD power plug from AC outlet.
(2) Turn selector switch to 2mA.
(3) Turn off power to the circuit under test.
(4) Connect test leads so that MICROGUARD is in series with the circuit under test.
(5) Turn on power to the circuit under test and select appropriate current range (2mA, 200uA, or 20uA).

3.0 VOLTAGE MEASUREMENTS

The MICROGUARD may be used as an AC or DC voltmeter. It will indicate the absolute value of a DC voltage, regardless of polarity, and the RMS value of an AC voltage.

(1) Disconnect MICROGUARD power plug from AC outlet.
(2) Turn selector switch to appropriate voltage range (200V, 200mV, or 20mV).
(3) Connect the test leads to the voltage source to be measured.

CAUTION: Do not touch the metal parts of the test leads while making voltage measurements as they may be exposed to live voltage.

4.0 LEAKAGE CURRENT OF 2-WIRE APPLIANCES (in conformance with proposed USA Standard, C101.1)

(1) Turn selector switch to 2mA.
(2) Plug appliance into MICROGUARD receptacle.
(3) Plug MICROGUARD power plug into 3-wire, 120 VAC outlet.
(4) Connect red test lead of MICROGUARD to all exposed conductive surfaces of appliance, and note maximum meter reading.

(5) Reverse the plug of the appliance in the MICROGUARD receptacle.
(6) Again, connect red test lead to all exposed conductive surfaces of the appliance, and note maximum meter reading.
(7) Readings should not exceed 0.5mA in either case.

VII. MAINTENANCE

1.0 INTRODUCTION

The Bio-Design MICROGUARD is designed to give long and reliable operation with a minimum of maintenance. Periodically, it will be necessary to change batteries. Follow the procedure given below. Occasionally, the front panel should be removed and the inside of the instrument cleaned of accumulated dust and grit. Instructions are also given below for the meter zero adjustment and circuit zero adjustment. These procedures may be necessary after batteries are replaced.

2.0 TO REMOVE FRONT PANEL

(1) Be sure MICROGUARD power plug is disconnected from AC outlet and selector switch is turned off.
(2) Remove the four (4) screws located at the corners of the front panel.
(3) Lift the panel straight up, grasping the selector knob and the left hand fuse holder. Do not grasp the meter.

3.0 TO REPLACE BATTERIES

(1) Remove panel as instructed above.
(2) Place panel face down on paper or cloth to avoid scratching meter face.
(3) With batteries toward you (see Figure 16), replace right-hand battery if BATT+ reads low. Replace left-hand battery if BATT- reads low. Replace with Mallory type TR134 battery or equivalent.

These may be ordered from Bio-Design, Inc., or may be purchased at a local distributor.

(4) Be sure batteries are properly seated in battery holders. If the meter pointer deflects past full-scale when the MICROGUARD is turned on, most likely the batteries are not making proper contact with the terminals of the holder. Move or rotate each battery slightly until the meter reading is normal.

NOTE: Adhesive tape is used to secure the batteries during shipment. When replacing batteries simply remove tape and discard.

4.0 TO REPLACE INPUT FUSES

(1) To test input fuses, turn selector switch to OHMS and short test leads together. If pointer does not move, one input fuse is most likely blown.
(2) Disconnect MICROGUARD plug from AC outlet.
(3) Twist cap of fuseholder 1/4 turn counterclockwise and pull out.
(4) Replace fuse, push cap in and twist 1/4 turn clockwise. Use only Littelfuse, type 312.125. Other types of fuses have too high a resistance and will not allow proper zero adjustment of OHMS scale.

5.0 TO REPLACE AC FUSE

(1) Disconnect MICROGUARD plug from AC outlet.
(2) Remove panel as instructed in paragraph 2.0.
(3) Remove fuse from fuse clip which is located next to meter (see Figure 6).

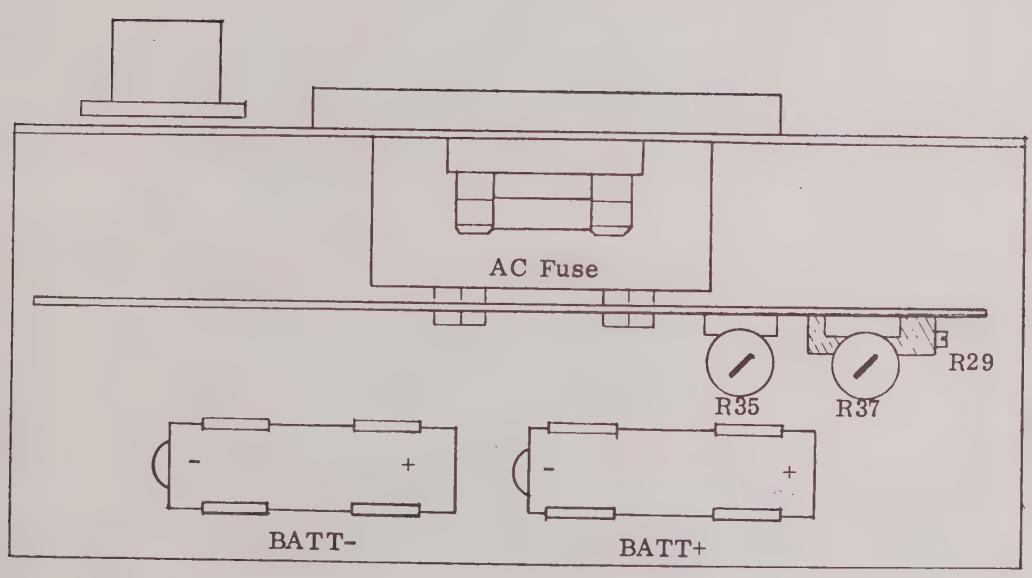


Figure 16. Fuse, battery and potentiometer locations.

6.0

7.0

8.0

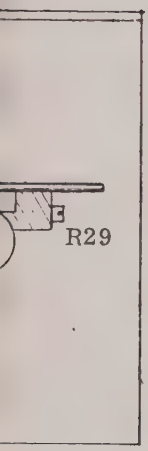
(4) Replace fuse with Littelfuse, type 3AB, 10 Amp or equivalent.

6.0 METER MECHANICAL ZERO ADJUSTMENT

(1) Place the MICROGUARD so that the meter is horizontal, face up.
(2) Turn the selector switch to OFF.
(3) If the pointer is off zero, slowly adjust the small black screw below the meter face with a small screwdriver, until the pointer is exactly over the zero mark at the left side of the scale.

7.0 ELECTRICAL ZERO ADJUSTMENT

(1) Remove the panel as instructed in paragraph 2.0 and place so that meter is horizontal, face up.
(2) Turn the selector switch to 2mA.
(3) Locate R29, a rectangular potentiometer behind the leakage receptacle. (See Figure 16)
(4) With a small screwdriver, slowly adjust R29 so that the pointer rests as far to the left as possible. Over-adjustment will cause the pointer to move back to the right.



8.0 CALIBRATION

MICROGUARD has been designed and constructed using precision components and should never need calibration if properly adjusted and subjected to normal usage.

However, it may be desirable to calibrate the instrument for use as a secondary standard or for a performance check after severe handling or electrical overload. Follow the procedure given below.

8.1 Test Equipment Required

(1) Power supply, 0 to 20 volts DC.
(2) Voltmeter, DC, digital ± 0.1% accuracy or better.
(3) Voltmeter, AC, ± .5% accuracy or better at 60Hz.
(4) Resistor, precision 1.0 Megohm, ± 1%, 1/2W, type RN65D or equivalent.
(5) Resistor, precision, 2.0 ohms ±1%, wirewound.
(6) Variable Autotransformer, 0 - 120VAC, 60Hz.

8.2 Perform zero adjustment procedures of sections 6.0 and 7.0.

8.3 DC Calibration

(1) Remove MICROGUARD panel from case, as instructed in paragraph 2.0 and place so that the meter is horizontal, face up.
(2) Connect test equipment as shown in Figure 17.
(3) Set DC power supply to 20.0V DC.
(4) Set MICROGUARD selector switch to 20uA range.
(5) Adjust R37 with a small screwdriver so that MICROGUARD meter reads 20.0uA.

8.4 AC Calibration (Always perform 8.3 first)

(1) Set MICROGUARD selector switch to 20uA range.
(2) Connect test equipment as shown in Figure 18.
(3) Adjust Variable Transformer for a reading of 20.0VAC on AC Voltmeter.
(4) Adjust R35 until MICROGUARD meter reads 20.0uA.

8.5

8.5 OHMS Calibration

(1) Equipment required: 1. Digital voltmeter
2. Resistor, 2.0 ohms, ± 1%

(2) Perform zero adjustment procedure of Section VII, paragraphs 6.0 and 7.0.

(3) Set Selector Switch to OHMS.

(4) Connect 2.0 ohm, 1%, resistor across Microguard test leads. Simultaneously connect digital voltmeter leads across 2.0 ohm resistor.

(5) Adjust 500-ohm potentionmeter R4 on Microguard 2" x 2" circuit card until digital voltmeter reads 10.0 millivolts DC.

(6) Short test leads together and adjust ZERO OHMS control for meter reading of 0 ohms.

(7) Connect 2.0 ohm resistor across Microguard test leads. Meter should indicate 2.0 ± .1 ohms.

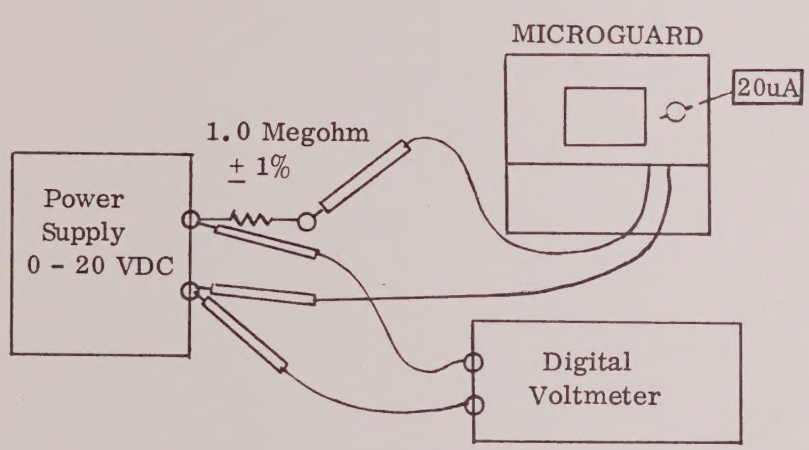


Figure 17. DC Current Calibration Setup

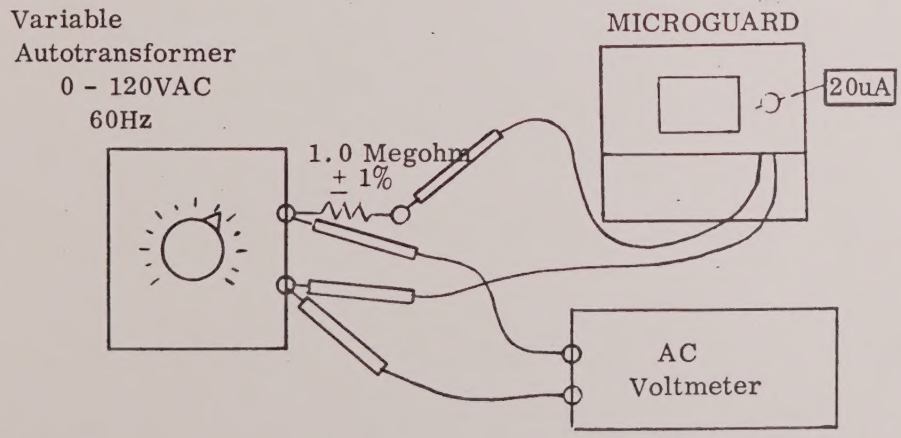


Figure 18. AC Voltage Calibration Setup